29 NOV 2001

<u>**MEMORANDUM**</u>

SUBJECT: Indoor House Dust Cleanup Goal for Lead
Herculaneum Lead Smelter
Herculaneum, Missouri

FROM: Mike Beringer, Toxicologist
SACR

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Superfund

TO: Bruce Morrison, Remedial Project Manager
FFSE

As you requested, I have developed an indoor house dust cleanup goal for lead in residences located in Herculaneum, Missouri. Because the U.S. Environmental Protection Agency (EPA) has not defined a standard for indoor house dust, the Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children, Windows version, was used to derive the house dust cleanup goal (EPA, 2001a, 2001b). All assumptions and exposure parameters are either discussed below or included in the attached model outputs.

1. Integrated Exposure Uptake Biokinetic Model

The IEUBK model is a computer-based deterministic simulation that estimates a plausible range of blood lead (PbB) concentrations for a hypothetical child or population of children (0 to 84 months) resulting from their exposure to environmental sources of lead, including soil, dust, air, drinking water, and diet (EPA, 1994a, 1994b). The model estimates the intake and uptake of lead into the body and then uses biokinetic modeling to predict a distribution of blood lead levels. From this distribution, the model estimates the risk (i.e., probability) that a child's or a population of children's PbB concentration will exceed a certain level of concern (typically 10 μg/dL).

In 1994 and 1998, the Office of Solid Waste and Emergency Response (OSWER) issued separate directives that: (1) recommend using the IEUBK Model for Lead in Children as the primary tool for setting risk-based soil cleanup levels at lead sites for current or future residential land use; (2) state that the IEUBK model is the best tool currently available for predicting the potential blood lead (PbB) levels of children (under the age of seven) exposed to lead in the environment; and (3) describe OSWER's health protection goal of limiting exposure to soil lead levels such that a full-time child resident would have an estimated probability of no more than

5% of exceeding a 10 µg/dL blood lead level (EPA, 1994c, 1998). The basis for this goal is that health effects associated with childhood lead exposure have been determined to occur at or below a PbB concentration of 10 µg/dL (EPA, 1986, 1990; CDC 1991).

While the IEUBK model is typically used to determine appropriate cleanup levels for lead in soil, the model can also be used to estimate PbB concentrations following abatement actions designed to reduce exposure levels from one or more environmental media. For example, one can estimate house dust levels necessary to achieve and maintain EPA's health protection goal, assuming that residential yards have been remediated to a certain level. It is possible to consider indoor house dust separately because the IEUBK model apportions total soil ingestion between outdoor soil (45%) and indoor dust (55%). In most cases, a significant portion of house dust is derived from outdoor soil that is primarily tracked into the house. The IEUBK model uses a default soil-to-dust transfer coefficient of 70% to describe the mass fraction derived from outdoor soil. The model also accounts for the contribution of atmospheric deposition (i.e., airborne lead) to house dust. This pathway is significant for those residences impacted by airborne lead emitted from the Herculaneum Lead Smelter.

2. Derivation of Indoor House Dust Cleanup Goal for Lead

To derive an indoor house dust cleanup goal for lead, all input parameters in the IEUBK model were set to EPA-specified default values, except for the outdoor lead soil and air concentrations (EPA, 2001a, 2001b). The outdoor lead soil concentration was specified as 400 mg/kg based on the assumption that remediation to this level has occurred, while the outdoor lead air concentration was set equal to the National Ambient Air Quality Standard of 1.5 mg/m^3. It is important to note that this assessment assumes no additional contribution of lead from local dietary sources, such as fruits, vegetables, meat, and fish.

Multiple runs were conducted for a range of dust concentrations using the Windows version of the IEUBK model (EPA, 2001a, 2001b). The results indicate that an indoor house dust concentration of 168 µg/g will achieve the Agency's goal of no more than a 5% probability of exceeding a 10 µg/dl blood lead concentration in children 0 to 84 months of age. This value represents the total concentration of lead in indoor house dust, irrespective of whether it was derived from outdoor soil or atmospheric deposition.

Attachment 1 contains the input parameters for the various exposure pathways and predicted geometric mean blood lead concentrations. The attached probability density plot shows the best estimate of a plausible range of PbB concentrations for a hypothetical child or population of children under the specified lead exposure scenario (Attachment 2). The portion of the upper tail of the probability distribution exceeding 10 µg/dl provides an estimate of the risk of exceeding that level for a typical child of 0 to 84 months of age residing in the same household and with the same exposure history. It can also be interpreted as the fraction of the population exceeding 10 µg/dl when all of those children have the same exposure history.

3. Uncertainties

A significant source of uncertainty in the IEUBK model is the actual level of lead exposure that children receive from various environmental sources, which is due to uncertainty regarding environmental concentrations and children's intake parameters. This assessment assumes that soil and air concentrations will remain constant at 400 mg/kg and 1.5 mg/m³, respectively, for 84 months of exposure. If concentrations of lead from any environmental sources increase or decrease, then the house dust cleanup goal will be affected. For example, if average soil concentrations are less than 400 mg/kg or average air concentrations are less than 1.5 mg/m³, then indoor house dust concentrations greater than 168 μg/g will achieve the EPA's health protection goal.

There is also uncertainty associated with the blood lead level predicted by the IEUBK model for the specified lead exposure scenario. Mathematical representation of complex biological processes being modeled is likely an oversimplification of what is actually occurring in children exposed to lead.

4. Summary

The IEUBK model, Windows version, was used to derive an indoor house dust lead cleanup goal for residences in Herculaneum, Missouri. Assuming an average residential soil concentration of 400 mg/kg and air concentration of 1.5 mg/m³, an indoor house dust concentration of 168 μg/g will achieve the EPA's health protection goal for children 0 to 84 months of age. The dust cleanup goal is also applicable to daycare facilities, schools, and other residences where a child may frequent.

5. References

CDC (Centers for Disease Control and Prevention). 1991. Preventing lead poisoning in young children.

U.S. EPA (U.S. Environmental Protection Agency). 1986. Air Quality Criteria for Lead. Vol. I-IV. Document No. EPA 600/8-83-028a-d. Research Triangle Park, N.C.: Environmental Criteria and Assessment Office.

U.S. EPA (U.S. Environmental Protection Agency). 1990. Report of the Clean Air Scientific Advisory Committee on Its Review of the OAQPS Lead Staff Paper. EPA-SAB-CASAC-90-002.

U.S. EPA (U.S. Environmental Protection Agency). 1994a. Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children. Version 0.99d. OSWER Directive No. 9285.7-15-1. Publication No. PB93-963510. Washington, D.C.: Technical Review Workgroup for Lead.

U.S. EPA (U.S. Environmental Protection Agency). 1994b. Technical Support Document: Parameters and Equations Used in the Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children. Version 0.99d. OSWER Directive No. 9285.7-22. Publication No. PB94-963505. Washington, D.C.: Technical Review Workgroup for Lead.

U.S. EPA (U.S. Environmental Protection Agency). 1994c. Revised Interim Soil Lead (Pb) Guidance for CERCLA Sites and RCRA Corrective Action Facilities. OSWER Directive No. 9355.4-12. Document No. EPA/540/R-94-039. Publication No. PB94-963504. Washington, D.C.: Office of Solid Waste and Emergency Response.

U.S. EPA (U.S. Environmental Protection Agency). 1998. Clarification to the 1994 Revised Interim Soil Lead (Pb) Guidance for CERCLA Sites and RCRA Corrective Action Facilities. OSWER Directive No. 9200.4-27P. Document No. EPA/540/F-98/030. Publication No. PB98-963244. Washington, D.C.: Office of Solid Waste and Emergency Response.

U.S. EPA (U.S. Environmental Protection Agency). 2001a. User's Guide for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK). Windows version. OSWER Directive No. 9285.7-42. Document No. EPA/540-K-01-005. Washington, D.C.: Technical Review Workgroup for Lead.

U.S. EPA (U.S. Environmental Protection Agency). 2001b. Reference Manual: Documentation of Updates for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK). Windows version. OSWER Directive No. 9285.7-44. Document No. EPA/540-K-01-007. Washington, D.C.: Technical Review Workgroup for Lead.

Attachments

LEAD MODEL FOR WINDOWS Version 1.0

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Model Version: 1.0
User Name: Mike Beringer
Date: 11/26/2001
Site Name: Herculaneum Lead Smelter
Operable Unit: 01
Run Mode: Site Risk Assessment
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Air Data
Outdoor Air Concentration = 1.5 mg/m3 (National Ambient Air Quality Standard)
Soil/Dust Data
Soil Concentration = 400 ug/g
Indoor Dust Concentration = 168 ug/g
Run the Model

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================================================================================
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The time step used in this model run: 4 - Every 15 Minutes (96 times a day).

******Air******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc ug Pb/m^3
.5-1	1.000	2.000	32.000	1.500
1-2	2.000	3.000	32.000	1.500
2-3	3.000	5.000	32.000	1.500
3-4	4.000	5.000	32.000	1.500
4-5	4.000	5.000	32.000	1.500
5-6	4.000	7.000	32.000	1.500
6-7	4.000	7.000	32.000	1.500

******Diet******

Age	Diet Intake(ug/day)
.5-1	5.530
1-2	5.780
2-3	6.490
3-4	6.240
4-5	6.010
5-6	6.340
6-7	7.000

******Drinking Water******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 ug Pb/L

******Soil& Dust******

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
.5-1	400.000	168.000
1-2	400.000	168.000
2-3	400.000	168.000
3-4	400.000	168.000
4-5	400.000	168.000
5-6	400.000	168.000
6-7	400.000	168.000

******Alternate Intake******

Age	Alternate (ug Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

******Maternal Contribution: Infant Model******
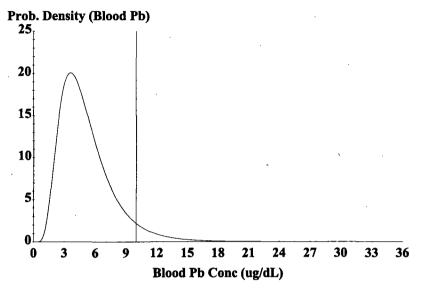
Maternal Blood Concentration: 2.500 ug Pb/dL

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CALCULATED BLOOD LEAD AND LEAD UPTAKES:

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Year	Air (ug/dL)	Diet (ug/day)	Alternate (ug/day)	Water (ug/day)
5-1	0.316	2.490	0.000	0.360
1-2	0.516	2.569	0.000	0.889
2-3	0.930	2.925	0.000	0.937
3-4	1.000	2.854	0.000	0.970
4-5	1.000	2.820	0.000	1.032

5-6	1.400	3.004	0.000	1.099
6-7	1.400	3.331	0.000	1.123

Year	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
.5-1	6.256	9.423	5.1
1-2	9.808	13.783	5.7
2-3	9.945	14.737	5.4
3-4	10.092	14.915	5.2
4-5	7.670	12.523	4.4
5-6	6.969	12.471	3.9
6-7	6.611	12.466	3.6

Prob. Density (Blood Pb)

Cutoff = 10.000 ug/dl
Geo Mean = 4.714
% Above = 4.994
% Below = 95.006

Age Range = 0 to 84 months
Time Step = Every 15 Minutes
Run Mode = Site Risk Assessment